1. INTRODUCTION

1.1 EMPACT Overview

This handbook offers step-by-step instructions about how to provide timely water quality data to your community. It was developed by the U.S. Environmental Protection Agency's (EPA's) **E**nvironmental **M**onitoring for **P**ublic **A**ccess and **C**ommunity **T**racking (EMPACT) program. The EMPACT program was created by EPA's Office of Research and Development (ORD) to introduce new technologies that make it possible to provide timely environmental information to the public. EMPACT has worked with several of the largest metropolitan areas and Native American Tribes in the country to help these communities:

- Collect, manage, and distribute timely environmental information.
- Provide residents with easy-to-understand information they can use in making informed, day-to-day decisions.

To make this and some other EMPACT projects more effective, partnerships with the National Oceanic and Atmospheric Administration (NOAA) and the United States Geological Survey (USGS) were developed. EPA works closely with these federal agencies to help achieve nationwide consistency in measuring environmental data, managing the information, and delivering it to the public.

Environmental information projects were initiated in more than 86 of 156 EMPACT-designated metropolitan areas and Native American Tribes. These projects cover a wide range of environmental issues, including water quality, groundwater contamination, smog, ultraviolet radiation, and overall ecosystem quality. Some of these projects were initiated directly by EPA. Others were launched by communities themselves. Local governments from any of the 156 EMPACT metropolitan areas and Native American Tribes were eligible to apply for EPA-funded Metro Grants to develop their own EMPACT projects. The 156 EMPACT metropolitan areas and Native American Tribes are listed in the table at the end of this chapter.

One such Metro Grant recipient is the Chesapeake Bay EMPACT Project. The project provides the public with timely water quality monitoring data and impacts of water quality management activities in the Baltimore - Washington Area. The EMPACT project also supplements Maryland DNR efforts to characterize water quality conditions in estuarine systems that have experienced or have the potential to experience harmful algal blooms.

1.2 Background

The Chesapeake Bay is the largest estuary in the United States and one of the most productive in the world. It is approximately 200 miles long and varies in width from 4 to 30 miles across. The Bay watershed drains 64,000 square miles of land in six states - Maryland, Virginia, Delaware, Pennsylvania, West Virginia and New York and Washington D.C. The Bay area is home to approximately 16 million people and supports nearly 2,700 different plant and animal species.

Scientific and estuarine research conducted on the Bay between 1976 and 1983 pinpointed four problems requiring immediate attention: nutrient enrichment, sediment loading, dwindling underwater Bay grasses, and toxic pollution. These findings led to the development of the Chesapeake Bay Program in 1983 and the Chesapeake Bay Monitoring Program in 1984, which monitors the overall health of the Bay through the collection of comprehensive data on physical, chemical and biological characteristics throughout the year in the main-stem of the Bay and tributaries. Information obtained through these programs is vital to evaluate the progress of management actions aimed at restoring the Bay and its tributaries, to address emerging issues such as *Pfiesteria*, and to provide guidance for future actions.

In 1997, toxic *Pfiesteria piscicida* (fee-STEER-ee-uh pis-kuh-SEED-uh) killed thousands of fish in several of Maryland's Lower Eastern Shore tributaries to the Chesapeake Bay, including the lower Pocomoke River in Maryland and Virginia, the Chicamicomico River , and King's Creek in Maryland. *Pfiesteria piscicida* is a toxic dinoflagellate that has been associated with fish lesions and fish kills in coastal waters from Delaware to North Carolina. A natural part of the marine environment, dinoflagellates are microscopic, free-swimming, single-celled organisms, usually classified as a type of alga. The vast majority of dinoflagellates are not toxic. Although many dinoflagellates are plant-like and obtain energy by photosynthesis, others, including *Pfiesteria*, are more animal-like and acquire some or all of their energy by eating other organisms.

[Source: http://www.epa.gov/owow/estuaries/pfiesteria/fact.html#11]

A statewide *Pfiesteria*, water, and habitat quality monitoring program was initiated by the Maryland Department of Natural Resources (MD DNR) to measure key components of the ecosystem, including pollutant inputs, water quality, habitat and living resources. In conjunction with this program, the Chesapeake Bay EMPACT Project was established to provide timely information regarding water quality information and the relationship to possible toxic *Pfiesteria piscicida* outbreaks on the Pocomoke River. This project was meant to supplement data collected as part of the comprehensive *Pfiesteria* monitoring program that is integrated with water and living resource quality assessments through the broader Chesapeake Bay Monitoring Program. The EMPACT project enables people to learn more about Maryland's waterways and keep up to date with water quality and *Pfiesteria* issues.

In 1998, the first year of EMPACT continuous monitoring, two stations were established in the Pocomoke River to monitor various water quality parameters: one at Cedar Hall Wharf and the other in Shelltown. In 1999, another surface meter (sonde) was deployed on the Pocomoke at Rehobeth and a bottom meter was added at Cedar Hall Wharf. Data from the bottom meter provides information about possible differences between bottom and surface conditions.

For 2000, the project was expanded to provide a more bay-wide representation of water and habitat quality and potential impacts to living resources. Two sondes were depolyed in the Magothy River: one at Cattail Creek and one at Stonington. These stations provide data from a waterway in a more urban setting. The Stonington site is located adjacent to a large submerged aquatic vegetation (SAV) bed. SAV provides critical habitat for living resources and the restoration of SAV is critical to bay recovery. Two additional monitors were placed in lower eastern shore tributaries: one in the Chicamacomico River at Drawbridge and one in the Transquaking River at Decoursey Bridge. These two waterways have repeatedly shown evidence of *Pfiesteria*. Through a cooperative program with the National Aquarium in Baltimore (NAIB), data is also being collected from a station established in 2001 in the Baltimore Harbor adjacent to the Fort McHenry field station.

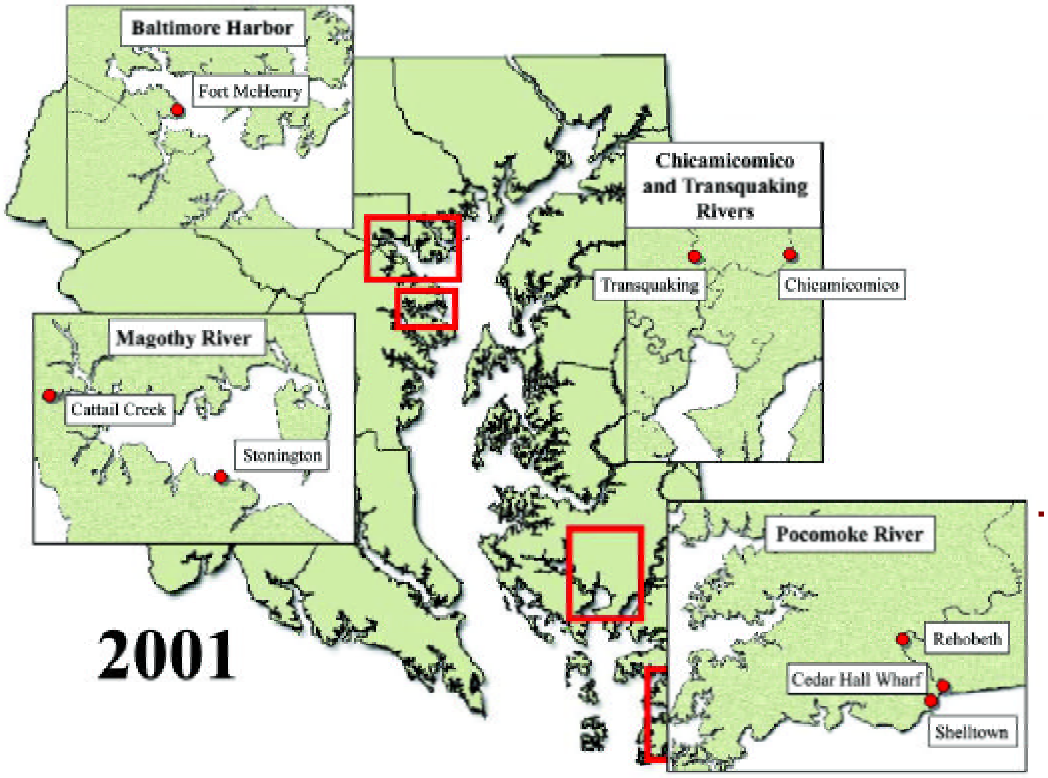
[Source: http://mddnr.chesapeakebay.net/empact/faq.html]

Initially, the monitoring stations were not equipped with telemetry to collect real-time data; however in 2000, most of the stations were outfitted with this equipment so that timely data could be collected. "Timely data" refers to data that is collected and communicated to the public in a time frame that is useful to their day-to-day decision-making about their health and the environment, and relevant to the temporal variability of the parameters measured. Figure 1.1 shows the geographical location of the monitoring stations.

In addition to supplementing the *Pfiesteria* program, this project provided a means to gain a greater understanding of how tributaries of the Chesapeake Bay function. For example, the relationship between storm events and fresh water flows to the Pocomoke is poorly understood because of its altered watershed hydrology resulting from human activities over the past several years. This is an important process to understand because of the likely linkage between runoff, nutrient loading, and conditions that influence *Pfiesteria* populations.

Other objectives of the EMPACT project were to measure and evaluate low dissolved oxygen conditions that affect certain Maryland waterways during the summer months and to evaluate SAV habitat conditions. Low oxygen conditions can stress fish and other aquatic organisms, and can lead to fish kills under severe conditions. SAV is a key living resource in Chesapeake Bay and provides valuable habitat for fish, crabs and other species.

Figure 1.1 Chesapeake Bay EMPACT Monitoring Stations



1.3 Chesapeake Bay EMPACT Project

Note: The National Aquarium in Baltimore (NAIB) project is discussed in Chapter 7.

1.3.1 Overview

The Chesapeake Bay EMPACT project was initiated in 1998 and ended in 2001. During that time, the Chesapeake Bay EMPACT project maintained as many as eight continuous water quality monitoring sites. Most sites were equipped with sampling and telemetry equipment. Timely data was available from the Rehobeth and Cedar Hall Wharf Stations on the Pocomoke River, the Stonington Station on the Magothy River, the Drawbridge Station on the Chicamacomico River, the Decoursey Bridge Station on the Transquaking River, and from the Fort McHenry Field Station in Patpsco River. The data for the Shelltown site on the Pocomoke River and the Cattail site on the Magothy was downloaded manually by MD DNR scientists. [Source: http://mddnr.chesapeakebay.net/newmontech/contmon/index.cfm]

Note: Although the Chesapeake Bay EMPACT Project has ended, MD DNR continues to collect timely water quality data at many of the monitoring sites listed above. In some cases, the equipment has been moved to other sites to collect similar data.

The field monitors (or sondes) were located at a constant depth of one meter below the surface of the water, with the exception of Cedar Hall Wharf on the Pocomoke, which also has a surface and bottom meter. The sondes were programmed to record seven environmental parameters: water temperature, salinity, dissolved oxygen saturation, dissolved oxygen concentration, pH, turbidity, and fluorescence. Each parameter was recorded every 15 minutes. Once a week (May through October), the monitors were replaced with clean, recalibrated units. The data collected by the sondes were downloaded and reviewed using the software, EcoWatch® for Windows™, that was provided with the sonde. Scientists reviewed the data to identify and delete obvious erroneous data. After reviewing the data, the scientist sends the data to the Web site manager where graphs are prepared for placement on the EMPACT Web site for the public to view. The Web site manager also archives the data for long-term storage. A telemetry system, which includes cellular phones located in the sampling stations, transferred the near real-time monitoring results to the MD DNR and NAIB twice each day. These data were processed and stored in a database within minutes so that Web users could query and generate graphs of the data.

In addition to the data collected by the sondes, water samples were collected at each location weekly for analysis in the laboratory. The analyses were used to calibrate the sondes and to check the data for accuracy. Water samples were collected for nutrient analysis, Chlorophyll A levels, and water column respiration rates.

1.3.2 Chesapeake Bay EMPACT Project Objectives

Overall project objectives included the following:

- Record chemical and physical data that will provide an understanding of the environmental factors that contribute to the occurrence of harmful algal blooms and low dissolved oxygen occurrences in the Chesapeake and Coastal Bays.
- Provide *in-situ* timely data to the Maryland DNR that supplements state efforts for *Pfiesteria* surveillance monitoring and SAV restoration.
- Utilize high-frequency timely data along with weekly measurements to characterize physical conditions and time frames over which physical processes occur. Identification of recurring events and their associated physical conditions are used as a basis for the development of future monitoring schemes to optimize recognition of any signals, impacts or events in the tributaries.
- Provide comprehensive assessments of technical environmental data in an easy to understand format that will increase the public's understanding of factors contributing to the frequency of toxic outbreaks of *Pfiesteria* and *Pfiesteria*-like organisms, fish kills, low dissolved oxygen and the loss of SAV habitat.

1.3.3 EMPACT Project Team

The Chesapeake Bay Project team consisted of the following members and key partners:

I. Key Personnel

- Tony Allred, MD DNR - Data management oversite.
- Bruce Michael, MD DNR - EMPACT project coordination and management.
- Drew Koslow, Chris Aadland, Maryland DNR - Data management and analysis, Web site design and maintenance.
- Ned Burger, University of Maryland Chesapeake Biological Laboratory, Chris Trumbauer, MD DNR, and John Ungarelli, MD DNR - Responsibilities included field work and in-house downloading and archiving raw data from instruments following each weekly deployment, making and documenting any data deletions or conversions, and transferring the corrected data to DNR.
- Glenn Page, National Aquarium in Baltimore, Director of Conservation - oversees all conservation efforts for NAIB.
- Angie Lawrence, National Aquarium in Baltimore, Chesapeake Bay Program Manager - responsible for all tidal wetland restoration efforts, manages volunteers.
- Dan O'Connell, Maryland DNR - database manager/programmer, maintains the Chesapeake Bay EMPACT Web site.

II. Key Partners

- Maryland DNR, Resource Assessment Service, Tidewater Ecosystem Assessment Division.
- NAIB (National Aquarium in Baltimore).
- NOAA (National Oceanic and Atmospheric Administration).
- University of Maryland Center of Environmental Services, Chesapeake Biological Laboratory (CBL)/Horn Point Laboratory (HPL).
- Morgan State University.
- The Chesapeake Bay Program.
- Other local partners.

1.3.4 Project Costs

The costs to conduct a water quality monitoring project similar to the Chesapeake Bay Project can vary significantly. Factors affecting the cost include, but are not limited to, the size and location of your study area, the number and types of parameters you want to measure, the number of monitoring stations that you want to deploy, whether you want a telemetry system to receive timely data, the personnel needed to collect and analyze the data, the number of samples to collect, and the amount of new equipment which will need to be purchased.

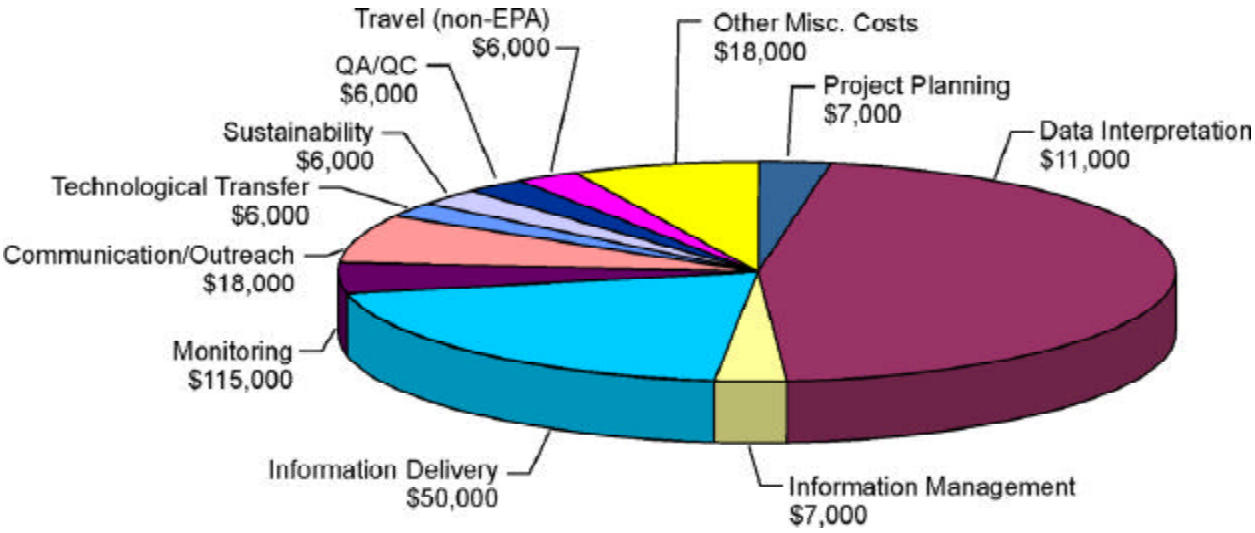
Each year from 1998 through 2000, Maryland's DNR applied for and received incremental EMPACT funding for their water quality monitoring program, totaling $475K. In 1998, the Chesapeake Bay EMPACT project received $100K to set up and maintain continuous monitoring at two sites on the Pocomoke River. Four sondes (two per monitoring site) were purchased for weekly collection of monitoring data. With an EMPACT Grant of $125K in 1999, four more sondes were purchased and set up to provide continuous monitoring at two additional sites on the Pocomoke. No telemetry was installed during these two years. A grant of $250K in 2000 enabled the Chesapeake Bay project to expand its continuous monitoring program Bay-wide. Two sites on the Magothy River and one site each on the Transquaking and Chicamacomico Rivers were set up, requiring the purchase and maintenance of eight additional sondes. With the additional funds, the purchase and use of telemetry was also initiated.

Figure 1.2 provides an example of the expenditure breakdown for the major project phases/tasks which occurred in 2000. In addition to EMPACT Grant funding, Maryland DNR provided funding for nutrient analysis, and staff time for project oversight, data management, data analysis and interpretation, and information dissemination. The University of Maryland also provided staff time for project oversight. [Source: EMPACT EPA Project Plan 2000, Revised January.]

One should keep in mind that significant initial capital costs may be incurred when implementing such a monitoring effort. For example, if you need to purchase equipment to measure parameters (i.e., sondes) or if you want to have access to timely data which would require telemetry hardware and software, then you should account for such expenditures. A monitoring station equipped with sondes and electronic hardware for a telemetry system can cost $17,000 to $22,000, excluding the manpower necessary for maintaining the equipment.

Added to this are annual costs for staff time necessary for sample collection and maintaining the sondes, data management, data analysis, and Web page maintenance. Utilizing a telemetry system also has additional costs such as cell phone charges.

Figure 1.2 Chesapeake Bay EMPACT Grant (FY2000)



1.3.5 Technology Transfer Handbook

The Technology Transfer and Support Division of the EPA's ORD National Risk Management Research Laboratory initiated development of this handbook to help interested communities learn more about the Chesapeake Bay Project. The handbook also provides technical information communities need to develop and manage their own timely water monitoring, data visualization, and information dissemination programs. ORD, working with the Chesapeake Bay Project team, produced this handbook to leverage EMPACT's investment in the project and minimize the resources needed to implement similar projects in other communities.

Free copies of both print and CD-ROM versions of the handbook are available for direct on-line ordering from EPA's Office of Research and Development Technology Transfer Web site at http://www.epa.gov/ttbnrmrl. A PDF version of the Handbook can be downloaded directly from the same Web site. You can also order a copy of the handbook (print or CD-ROM version) by contacting ORD Publications by telephone or mail at:

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We hope you find the handbook worthwhile, informative, and easy to use.